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Ethnoveterinary medicines plants for animal therapy in the Rif, North of Morocco.

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ABSTRACT

Phytotherapy has been playing a significant role in the livestock health care system for a long especially in remote areas. This study was aimed to document the therapeutic uses of plant species practiced by the indigenous people of the Rif for the treatment of various veterinary health diseases. Semi-structured questionnaires, field walks, and group discussions were conducted during June 2016 - October 2019 to collect the data. Quantitative indices including Plant Part Value (PPV), Use value (UV), Fidelity Level (FL), Relative Popularity Level (RPL), Rank Order Priority (ROP), Jaccard Index (JI), and Informant Consensus Factor (ICF) were used for the data analysis. A total of 300 medicinal plants belonging to 205 genera and 67 families have been recorded with ethnoveterinary uses. Dominant families are Asteraceae (33 species), Lamiaceae (28 species), and Fabaceae (24 species). The reported illness was classified into 6 disease categories based on ICF values and the highest number of plants was reported to treat dermatological diseases (ICF=0.971). Leaves were the most consistently used parts (PPV=48.4%). *Aloysia citrodora* Palau. (RPL=) had the highest RPL level (1.15). It can be concluded that the local people of Rif hold rich ethnoveterinary knowledge to cure livestock diseases. Plant species with high FL, RPL, and UV values should be screened for comprehensive phytochemical and pharmacological studies to validate the ethnomedicinal knowledge.

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1. Introduction

Medicinal plants have always been used in popular methods of treatment for curing different ailments in humans of time immemorial and their uses have remained much in demand throughout the world (Gurib-Fakim, 2006; Sofowora et al., 2013). Moreover, medicinal plants also constitute the main part of traditional veterinary practices and have been proven to be a rich source of botanicals in animals for several centuries (McCorkle, 1995). Various plant formulations are also used in folk medicine as well as our traditional medicines like aromatherapy, homeopathy, naturopathy, allopathy, ayurvedic, Chinese, or oriental medicine.

According to the Food and Agricultural Organization (FAO), the lack of drugs to treat infections and diseases results in losses of 30–35% in the breeding sector of many developing countries, where poor animal health remains the major constraint to increased production (FAO, 2002). The documentations of traditional veterinary care use for the control and management of livestock diseases are the appropriate means of identifying potential sources of new drugs (Usman, 2016).

Ethnoveterinary - Ethnobotanical investigations have always been a great concern among researchers. Ethnoveterinary research has been employed by many workers all over the world in the past (Ali-Shtayeh et al., 2000; Bonet, 2001; Monteiro et al., 1998). Many studies assured that pastoralists and farmers in several countries such as Darjeeling District, India (Mondal, 2012), Tharparker, Sindh, Pakistan (Mirani et al., 2014), Nepal (Dhital and Pudasaini, 2019), Wolaita and Dawuro Zones, Ethiopia (Mesfin et al., 2016), Ngamiland District, Botswana (Gabalebatse et al., 2013), Northwest province, South Africa (Van der Merwe et al., 2001), and NW Yunnan, China (Shen et al., 2010) widely use medicinal plants in the conservation of the health of livestock.

Abbreviations: Co, Cooking; Cr, Crushing; D, Dermatological; De, Decoction; EEP, Endo-ecto parasitic; FAO, Food and Agricultural Organization; FL, Fidelity Level; GI, Gastro-intestinal; Gr, Grinding; ICF, Informant Consensus Factor; ICPC, International Classification of Primary Care; In, Infusion; JI, Jaccard Index; OHP, Other Health problems; Po, Powder; PPV, Plant Part Value; ROP, Rank Order Priority; RP, Respirarory Problems; RPL, Relative Popularity Level; UP, Urinary Problems; UV, Use Value

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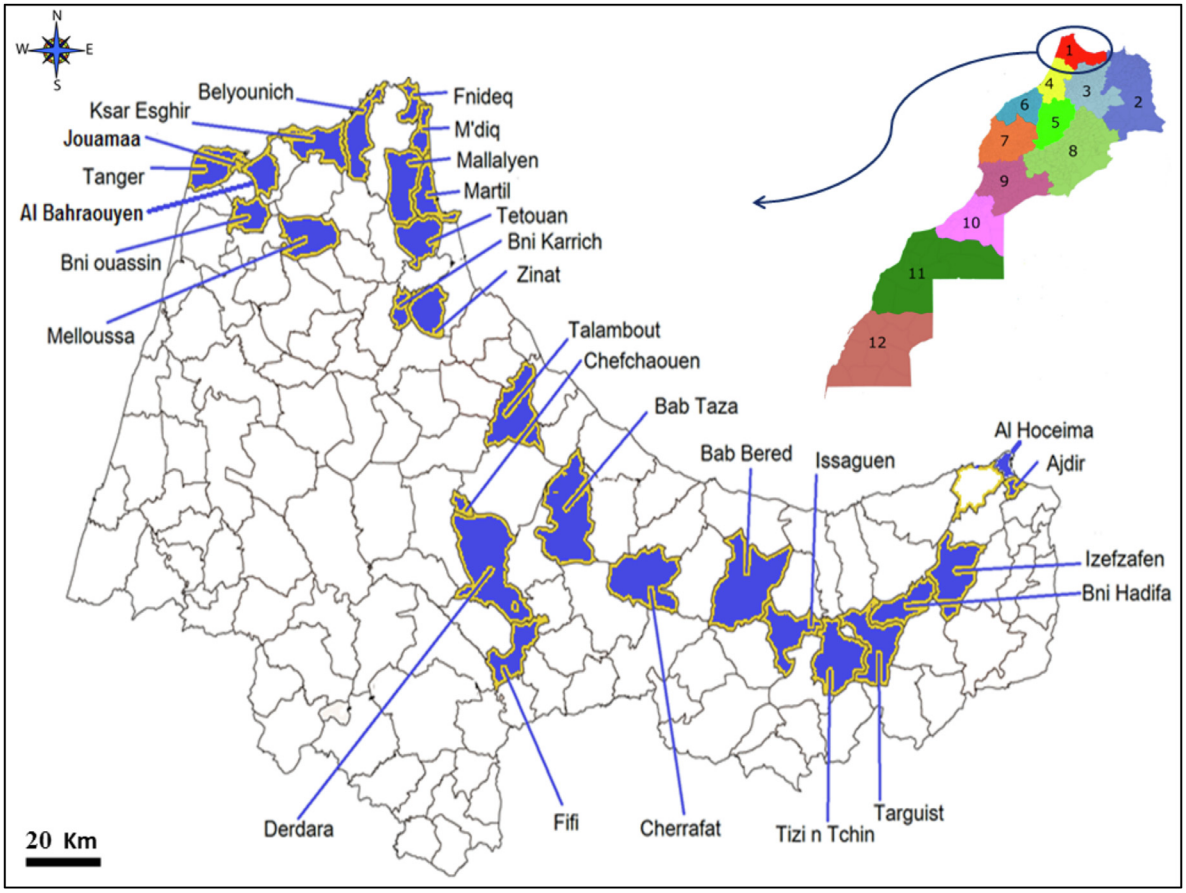

Fig. 1. Map of Morocco showing the study area of Rif.

Ethnoveterinary Medicine is a system based on folk traditional knowledge, beliefs, skills, methods, and practices for treating various disorders and diseases and maintaining the good health of our animals (Bhardwaj et al., 2011; Kumari et al., 2011). Ethnoveterinary Medicine is frequently used for curing animal as well as human disorders by many different people around the globe (Oyda, 2017). In many poor rural areas, EVM can play an important role in livelihood development and animal production, and often becomes the only available means for farmers to treat ill livestock (Iqbal et al., 2005; Shen et al., 2010).

Rif area bearing part of the Mediterranean region with a wide variety of flora and fauna has the lowest human development index in Chefchouaen province. Agriculture is the main source of the economy of the peoples of Rif. They have a rich heritage of indigenous knowledge (Benabid and Bellakhdar, 1987; N. Chaachouay, et al., 2019). Livestock production in the Moroccan regions is severely constrained by the presence of a wide range of animal diseases. These diseases not only affect the production and productivity of livestock but also seriously hamper any meaningful animal trade, especially among the poor rural farming communities. Hence, this work was conducted to document the use of indigenous ethnoveterinary knowledge of the herbs used in curing various ailments of animals by the local people of Rif.

2. Methods

2.1. Research area

This study was undertaken in the Rif area, northern Morocco. It is approximately 34 631 km^2 and bordered by the Mediterranean Sea to the north, Algeria to the east, the plains between the Middle Atlas to the south, and the Atlantic Ocean to the west. Composed of mountains and plains, the Rif stretches for nearly 500 km from Tangier to Moulouya (Fig. 1). The region lies between the parallels of 34° and 36° N latitude and 4° to 6° E longitude (HCP, 2018). The Rif is marked by Mediterranean weather. The metrological data of the study area indicate that the highest temperature up to 45 °C during summer (July–August) and below 0 °C during winter (December–January) and the average annual rainfall ranges from 700 to 1 300 mm which falls mainly between October and February (DMNM, 2018). The altitude of the study area ranges from 145 to 2 456 m a.s.l.

The vegetation of the area is dominated by phanerophyte plants such as *Tetraclinis articulata* (Vahl) Mast., *Cedrus atlantica* (Endl.) Manetti ex Carrière, *Quercus ilex* L., *Quercus suber* L., *Eucalyptus globulus* Labill., *Abies marocana* Trab., and *Cupressus atlantica* Gaussen. The livestock available in this study area is sheep, goats, cows, cattle, mules, poultry, camels, and horses. Principally inhabitants of Rif are very greatly reliant on subsistence agriculture, livestock farming, and to a minor extent, forest reserves for their livelihood (N. Chaachouay et al., 2021).

2.2. Ethnobotanical survey

From June 2016 to October 2019, a field investigation was done to collect the data using semi-structured ethnoveterinary interviews. Interviews with 500 informants were done including 386 male and 114 female, cattle holders, shepherds, nomads, knowledgeable elders, local farmers, and traditional practitioners from different parts of the area, whose ages ranged from 23 to 95 years old. Only informants who were either native-born or had been living in the Rif region for more than 20 years were taken into consideration and based on their traditional knowledge regarding livestock treatment (Table 1).

Table 1
Demographic characteristics of informants in the study area.

Factor	Categories	Number of informants	Percentage
Sex	Male	386	77.2%
	Female	114	22.8%
Age groups	Above 60	270	54%
	20–40	216	43.2%
	Under 20	14	2.8%
Educational background	Illiterate	225	45%
	Primary school	174	34.8%
	Secondary school	96	19.2%
	University	5	1%
Locality	Rural area	340	68%
	Village	141	28.2%
	Nomadic	13	2.6%
	Urban area	6	1.2%
Occupation	Knowledgeable elders	146	29.2%
	Traditional practitioners	113	22.6%
	Cattle holders	94	18.8%
	Shepherds	76	15.2%
	Local Farmers	59	11.8%
	Nomads	12	2.4%

The methods for the collection of data and voucher specimens during the field study followed that described by Martin and Godron (Godron, 1971; Martin, 1995). Twenty eiht geographical sites were investigated; they were: Site 1: Al Hoceima, Site 2: Ajdir, Site 3: Izefzafen, Site 4: Bni Hadifa, Site 5: Targuist, Site 6: Tizi n Tchin, Site 7: Issaguen, Site 8: Bab Berred, Site 9: Cherrafate, Site 10: Bab Taza, Site 11: Derdara, Site 12: Chefchaouen, Site 13: Akchour, Site 14: Fifi, Site 15: Tétouan, Site 16: Bni Karrich, Site 17: Mallalyeene, Site 18: Zinat, Site 19: Martil, Site 20: Md'q, Site 21: Fnideq, Site 22: Belyounich, Site 23: Melloussa, Site 24: Ksar Esghir, Site 25: Bni Ouassin, Site 26: Tanger, Site 27: Al Bahraouiyne, and Site 28: Jouamaa. We selected these study sites based on the availability of practice of traditional medicine and the recommendations of agricultural developing agents and local authorities.

The questionnaire was prepared and designed (Annex A), which comprised of two parts i.e. the first part contained socio-demographic features of the participants included age, gender, occupation, education, community, number of livestock, if any, etc. The second part is devoted to the medicinal plants frequently used for curing various ailments of the animals, such as local plant names, parts used, methods of preparation, the dosage used, mode and route of application, and diseases treated. Descriptions of the most common diseases during interviews were usually accurate. Identification of specific livestock ailment types in the area was found to be made based on age-old cultural knowledge on symptoms and corresponding livestock illnesses held in the memories of indigenous people. Questionnaires were first developed in English, later translated into local languages, i.e. Arabic dialect and Amazigh.

2.3. Plant species identification

Voucher specimens were collected for each plant species. All data collections were done with special care based on the cultural view of the local sites in the study area. The medicinal plant species used for the treatment of livestock diseases by the local communities of the study area were authenticated using the World Flora Online (http://www.worldfloraonline.org), the Kew Botanic Garden Medicinal Plant Names Services (http://www.kew.org/mpns), the international plant name index (http://www.ipni.org), and GRIN taxonomy site (http://www.ars-grin.gov/cgi-bin/npgs/html/queries.pl), while that of families follow A.P.G. system (Stevens, 2001). Collected plant species were identified by the professional expert Prof. Dr. Zidane L by using available taxonomic literature manuals and floras, especially Moroccan vascular flora: inventory and chorology (Fennane and Ibn Tattou, 2012), Moroccan Flora Practice: Vascular Plant Determination Manual; Pteridophyte, Gymnosperm, Angiosperm (Fennane et al., 1999), Practical flora from Morocco. Volume 2 (Fennane and Ibn-Tattou, 2007), Morocco Practice Flora, Volume 3 (Fennane et al., 2014), and Catalogue of vascular plants of Northern Morocco, including identification keys (Valdés, 2002).

2.4. Ethical approval and consent to participate

Informed consent from the local authorities is obtained to participate in this study before obtaining information on useful plants within the local communities. After that, permission was obtained from all participants of the Rif were informed about the research work and their benefits to the whole society. Indigenous people were allowed to discontinue the interviews at any time.

2.5. Ethics statement

The study was authorized by the *Ethics Committee of Plant, Animal Productions and Agro-industry Laboratory, Department of Biology, Faculty of Sciences, Ibn Tofail University* through No. NHEL/2016/06/06.

2.6. Quantitative ethnobotanical data analysis

The data collected by interviewing participants were analyzed by various quantitative indices such as Plant Part Value (PPV), Use value (UV), Fidelity Level (FL), Relative Popularity Level (RPL), Rank Order Priority (ROP), Jaccard Index (JI), and Informant Consensus Factor (ICF).

2.5.1. Plant part value (PPV)

Plant part value (PPV) was calculated using the following formula (N. Chaachouay, et al., 2019): $PPV = RU_{Plant} \frac{part}{RU}$ Where RU is the number of uses reported of all parts of the plant and RU_{Plant} part is the sum of uses reported per part of the plant. The part with the highest PPV is the most used by the informants.

2.6.2. Use value (UV)

The use-value, a quantitative method that demonstrates the relative importance of species known locally. The UV of reported species was calculated using the following formula (Tabuti et al., 2003): $UV = \frac{\sum^{U_R}}{n}$. Where UV is the use value of species, '$\sum^{U_R}$' is the total number of use reports per species and 'n' represents the total number of informants interviewed for a given plant. UVs will be higher if there are many useful reports for a plant, implying that the plant is

Table 2
Catalog of plant species used by the people of Rif for ethnoveterinary purposes.

Family and scientific name	Vernacular name	Used parts	Method of preparation/ administration mode	Therapeutic uses	Animal species	UR	UV	FL
Aizoaceae								
Mesembryanthemum acinaciforme L.	Bousbayeaa	Aerial parts	Cr/Dermal	OHP, D	Cows, Goats	05	0.60	62
Amaranthaceae								
Atriplex halimus L.	Legtef	Leaf	De/Oral	EEP	Donkeys, Mules	7	0.57	71
Beta vulgaris L.	Lbarba	Seed	Co/Inhalation	OHP	Goats, Sheep	23	0.61	56
Chenopodium album L.	Baremren	Leaf	De/Oral	GI	Goats	11	0.64	63
Chenopodium ambrosioides L.	Mkhinza	Leaf	De/Oral	GI	Cows	82	0.83	58
Chenopodium murale L.	Talekutta	Leaf	Cr/Massage	EEP	Chickens	14	0.50	72
Spinacia oleracea L.	Sabanikh	Leaf	De/Oral	OHP	Sheep	45	0.51	51
Salsola kali L.	El Herd	Leaf	Cr/Massage	D	Donkeys	6	0.33	64
Amaryllidaceae								
Allium cepa L.	Bassla	Bulb	Gr/Dermal	GI	Goats	87	0.69	70
Allium porrum L.	Borro	Bulb	Cr/Dermal	GI, D	Donkeys, Mules	26	0.46	69
Allium sativum L.	Touma	Bulb	In/Oral	GI	Sheep	92	0.71	89
Anacardiaceae								
Pistacia atlantica Desf.	Btem	Leaf	De/Oral	OHP	Cats	74	0.54	50
Pistacia lentiscus L.	Drou	Leaf	Cr/Inhalation	RP	Goats	56	0.36	64
Pistacia terebinthus L.	Foustok	Leaf	De/Oral	UP	Sheep	41	0.42	74
Schinus molle L.	Foulfol kadib	Leaf	Gr/Massage	GI	Cows	17	0.39	68
Apiaceae								
Ammi majus L.	Tlillane	Leaf	De/Oral	GI, EEP	Donkeys, Goats	52	0.44	55
Ammi visnaga (L.) Lam.	Bechnikha	Leaf	Cr/Dermal	D	Sheep	36	0.39	71
Ammodaucus leucotrichus Coss.	Camoun Soufi	Seed	Co/Inhalation	GI	Goats	15	0.47	60
Apium graveolens L.	Lkrafess	Leaf	Cr/Massage	D	Mules	24	0.35	63
Carum carvi L.	Karwiya	Seed	De/Oral	GI	Sheep	51	0.37	64
Coriandrum sativum L.	Alkazbour	Aerial parts	De/Oral	UP	Cows	41	0.54	74
Conium maculatum L.	Choukran	Leaf	Gr/Dermal	OHP, D	Sheep, Goats	18	0.42	59
Cuminum cyminum L.	Camoun	Seed	De/Oral	RP	Goats	11	0.55	67
Daucus carota L.	Khizou	Leaf	Cr/Inhalation	RP	Chickens	30	0.28	80
Eryngium ilicifolium Lam.	El Asfour	Aerial parts	De/Oral	OHP, EEP	Sheep	10	0.60	68
Ferula communis L.	Lkalkha	Leaf	Gr/Massage	GI	Cows	21	0.47	62
Foeniculum vulgare Mill.	Lbesbas	Aerial parts	De/Oral	GI	Sheep	47	0.38	77
Petroselinum sativum Hoffm.	Maàdnous	Leaf	De/Oral	OHP	Sheep	46	0.61	54
Pimpinella anisum L.	Habbat Hlawa	Seed	De/Oral	RP	donkeys	19	0.48	48
Ridolfia segetum (L.) Moris	Slilo	Leaf	De/Oral	RP	Sheep	8	0.49	62
Smyrnium olusatrum L.	Lheyyâr	Fruit	Cr/Dermal	OHP	Goats	14	0.51	70
Thapsia garganica L.	Deryas	Whole plant	De/Oral	RP	Cows	18	0.37	52
Thapsia villosa L.	Bounafea	Whole plant	De/Oral	EEP	Sheep	8	0.46	47
Apocynaceae								
Caralluma europaea (Guss.) N.E.Br.	Daghmous	Leaf	De/Oral	GI	Goats	25	0.36	48
Nerium oleander L.	Defla	Leaf	In/Oral	GI	Cats	76	0.56	65
Vinca minor L.	El Innakia	Aerial parts	De/Oral	OHP	Chickens	4	0.52	53
Araliaceae								
Hedera helix L.	Louwaya	Leaf	Gr/Inhalation	RP	Sheep	24	0.51	52
Arecaceae								
Chamaerops humilis L.	Doum	Aerial parts	De/Oral	EEP	Sheep	53	0.48	78
Phoenix dactylifera L.	Tmar	Fruit	Cr/Massage	EEP	Cows, Goats	57	0.39	70
Aristolochiaceae								
Aristolochia baetica L.	Berztem	Leaf	Co/Dermal	D	Sheep, Goats	34	0.50	48
Asparagaceae								
Agave Americana L.	Sabra	Whole plant	De/Oral	OHP	Sheep	64	0.62	78
Agave sisalana Perrine.	Aloe Vera	Leaf	Co/Inhalation	EEP	Goats	12	0.51	65
Asparagus acutifolius L.	Sekkom	Aerial parts	De/Oral	GI	Mules	31	0.38	57
Asparagus densiflora Kunth	Tazzut	Aerial parts	Cr/Massage	GI	Dogs	15	0.58	69
Asparagus officinalis L.	Tazzut	Aerial parts	De/Oral	UP	Sheep	17	0.67	100
Asparagus plumosus Baker.	Sekkom	Aerial parts	De/Oral	GI, RP	Horses	10	0.46	82
Asparagus stipularis Forssk.	Tazzut	Aerial parts	Cr/Massage	EEP	Goats	6	0.35	76
Drimia maritima (L.) Stearn.	Ansal	Bulb	Cr/Dermal	GI	Sheep	41	0.47	69
Muscari comosum (L.) Mill.	Bsyla	Bulb	Gr/Inhalation	EEP	Cows	64	0.45	73
Asteraceae								
Achillea millefolium L.	Louiza Lehjar	Leaf	De/Oral	RP	Sheep	9	0.50	75
Anacyclus pyrethrum (L.) Lag.	Tiguentest	Root	De/Oral	GI	Mules	14	0.42	62
Anacyclus radiatus Loisel.	Far Dahabya	Whole plant	De/Oral	RP	Donkeys	3	0.56	58
Anthemis cotula L.	Arbyan	Leaf	Cr/Inhalation	EEP	Chickens	6	0.47	75
Artemisia absinthium L.	Chiba	Leaf	De/Oral	OHP, GI	Goats, Sheep	77	0.38	58
Artemisia herba-alba Asso.	Chih	Leaf	Cr/Massage	D	Cats	108	0.64	69
Artemisia mesatlantica Maire.	Izri	Leaf	De/Oral	RP	Chickens	73	0.36	87
Atractylis gummifera Salzm. ex L.	Addad	Whole plant	De/Oral	OHP, EEP	Cows, Sheep	60	0.78	58
Calendula arvensis M.Bieb.	Jemra, Azwiwel	Flower	Gr/Inhalation	RP	Goats	19	0.28	68
Calendula eckerleinii Ohle.	Jemra	Flower	Co/Massage	EEP	Sheep	14	0.54	58
Carduus getulus Pomel.	Lssan Maghribi	Leaf	De/Oral	OHP	Goats	10	0.45	74

(*continued*)

Table 2 (*Continued*)

Family and scientific name	Vernacular name	Used parts	Method of preparation/ administration mode	Therapeutic uses	Animal species	UR	UV	FL
Carduus martinezii Pau	Chok Mchaar	Leaf	Cr/Massage	EEP	Goats, Sheep	15	0.47	49
Carthamus rhiphaeus Font Quer & Pau.	EL Kertam	Whole plant	De/Oral	UP	Sheep	6	0.62	56
Chrysanthemum coronarium L.	Lgahwân	Flower	Cr/Dermal	EEP	Mules	15	0.34	67
Cynara humilis L.	Khorchef	Aerial parts	De/Oral	GI, UP	Sheep	52	0.35	50
Cynara scolymus L.	Lqoq	Whole plant	De/Oral	RP	Donkeys	41	0.54	58
Dittrichia viscosa (L.) Greuter.	Magraman	Leaf	Gr/Inhalation	EEP	Cows	66	0.65	69
Eupatorium cannabinum L.	El Kahra	Leaf	Co/Dermal	GI	Sheep	2	0.36	67
Helianthus annuus L.	Abbad Shems	Seed	De/Oral	RP	Sheep	24	0.48	80
Helichrysum italicum (Roth) G.Don	Dahab Eshams	Flower	Cr/Inhalation	OHP	Cats	10	0.47	47
Lactuca sativa L.	Elkhass	Leaf	De/Oral	GI	Sheep	29	0.38	58
Lactuca virosa Habl.	Ahchlaf Nssem	Leaf	Cr/Massage	D	Dogs	24	0.41	81
Matricaria chamomilla L.	Babunj	Aerial parts	De/Oral	GI	Goats	61	0.68	68
Matricaria recutita L.	Babunj Almani	Leaf	Cr/Massage	EEP	Goats	52	0.58	72
Ormenis mixta (L.) Dumort.	Hellâla	Aerial parts	De/Oral	D	Sheep	13	0.49	72
Scolymus hispanicus L.	Garnina	Aerial parts	De/Oral	OHP	Sheep	7	0.47	56
Silybum marianum (L.) Gaertn.	Tawra	Seed	De/Oral	EEP	Sheep	9	0.38	74
Sonchus asper (L.) Hill	Tifaf	Whole plant	De/Oral	OHP	Sheep	10	0.47	58
Sonchus fragilis Ball	Tifaf	Leaf	In/Oral	EEP	Horses	6	0.36	49
Sonchus oleraceus (L.) L.	Tilfaf	Whole plant	De/Oral	GI, EEP	Goats, Sheep	6	0.51	67
Sonchus tenerrimus L.	Tifaf	Leaf	Cr/Dermal	EEP	Mules	4	0.38	46
Tanacetum vulgare L.	Lbalssem	Leaf	Gr/Inhalation	GI, RP	Cows, Sheep	21	0.46	70
Xanthium spinosum L.	Lzik Chouki	Leaf	De/Oral	GI	Sheep	4	0.46	48
Berberidaceae								
Berberis hispanica Boiss. & Reut.	Berberis	Fruit	De/Oral	EEP	Goats	7	0.41	57
Brassicaceae								
Anastatica hierochuntica L.	Kaff Mariam	Root	De/Oral	RP	Sheep	28	0.52	67
Brassica fruticulosa Cirillo.	Harchae	Aerial parts	De/Oral	OHP	Chickens	25	0.53	49
Brassica oleracea L.	Karnabite	Leaf	Cr/Inhalation	EEP	Sheep	14	0.45	58
Brassica oleracea f. *alba* DC.	Melfouf	Aerial parts	De/Oral	GI, EEP	Cats	13	0.38	67
Brassica nigra (L.) K.Koch.	Khrdal	Aerial parts	De/Oral	RP	Sheep	10	0.36	57
Brassica rapa L.	Left Lbeldi	Fruit	Gr/Massage	OHP	Goats	8	0.51	48
Brassica rapa var. *annua* W.D.J.Koch.	Left	Fruit	In/Oral	EEP	Donkeys	9	0.37	58
Raphanus sativus L.	Fjel	Aerial parts	De/Oral	GI	Cows, Sheep	17	0.47	76
Lepidium sativum L.	Habb Rchad	Seed	De/Oral	UP	Mules	23	0.58	72
Sinapis alba L.	Karkaz	Aerial parts	De/Oral	GI, EEP	Goats, Sheep	20	0.28	48
Sinapis arvensis L.	Khardal	Aerial parts	Co/Massage	EEP	Sheep	8	0.54	64
Boraginaceae								
Anchusa italica Retz.	Lsan Etthawr	Flower	Cr/Dermal	D	Goats	6	0.37	56
Borago officinalis L.	El Hamhem	Flower	Gr/Massage	EEP	Goats	14	0.48	47
Cactaceae								
Opuntia ficus indica (L.) Mill.	Zaâboul	Fruit	Cr/Massage	OHP, D	Horses, Mules	54	0.54	91
Opuntia maxima Mill.	Kermous nsara	Fruit	Co/Dermal	EEP	Cows	17	0.60	49
Cannabaceae								
Cannabis sativa L.	Lkif	Seed	De/Oral	RP	Mules	57	0.47	90
Caryophyllaceae								
Arenaria rubra L.	Herras Lehjar	Whole plant	De/Oral	EEP	Donkeys	65	0.53	83
Corrigiola telephiifolia Pourr.	Sarghina	Whole plant	De/Oral	RP	Sheep	45	0.48	68
Silene ibosii Emb. & Maire.	Tigheghecht	Whole plant	In/Oral	EEP	Sheep	51	0.53	80
Silene vulgaris (Moench) Garcke	Tigheghet	Root	De/Oral	OHP	Sheep	42	0.28	78
Capparaceae								
Capparis spinosa L.	Kebbar	Seed	De/Oral	RP	Goats	48	0.57	83
Cistaceae								
Cistus albidus L.	Maknan	Seed	De/Oral	OHP	Sheep	8	0.47	49
Cistus ladanifer L.	Tarkal	Leaf	Co/Inhalation	GI	Chickens	6	0.38	79
Cistus salviifolius L.	Shtapa	Leaf	Gr/Massage	EEP	Dogs	5	0.42	77
Crassulaceae								
Umbilicus rupestris (Salisb.) Dandy	Sorrat El Ard	Aerial parts	De/Oral	RP	Sheep	4	0.39	68
Cucurbitaceae								
Bryonia dioica Jacq.	Aineb Edib	Leaf	Co/Massage	EEP	Goats	14	0.48	79
Citrullus colocynthis (L.) Schrad.	Lhdej	Seed	De/Oral	RP	Cats	70	0.71	100
Citrullus vulgaris Schrad.	Dlah	Leaf	De/Oral	RP	Sheep	24	0.35	68
Cucurbita maxima Duchesne	Elgraa Hamra	Seed	De/Oral	OHP, UP	Cows, Mules	16	0.45	59
Cucurbita pepo L.	Garaa Khedra	Fruit	Gr/Dermal	EEP	Sheep	14	0.56	49
Cucumis melo L.	Btikh	Leaf	De/Oral	GI, EEP	Mules, Donkeys	10	0.48	67
Ecballium elaterium (L.) A.Rich.	Faggous El Hemar	Fruit	In/Oral	RP	Donkeys	17	0.45	59
Lagenaria siceraria (Molina) Standl.	El garâa-slâwiya	Fruit	Cr/Inhalation	EEP	Chickens	6	0.54	58
Cupressaceae								
Cupressus sempervirens L.	Zembale	Leaf	Co/Massage	OHP	Sheep	54	0.52	79
Juniperus oxycedrus L.	Taqqa	Leaf	Cr/Dermal	D	Sheep	43	0.54	69
Juniperus phoenicea L.	Arar Finiqi	Leaf	In/Oral	OHP	Sheep	42	0.38	92
Tetraclinis articulata (Vahl) Mast.	El A'râr	Leaf	Cr/Dermal	EEP	Goats	76	0.76	100
Cyperaceae								
Cyperus rotundus L.	Tara	Leaf	De/Oral	EEP	Horses, Mules	6	0.45	48

(*continued*)

Table 2 (*Continued*)

Family and scientific name	Vernacular name	Used parts	Method of preparation/ administration mode	Therapeutic uses	Animal species	UR	UV	FL
Ericaceae								
Arbutus unedo L.	Bakhnnou	Leaf	Co/Inhalation	RP	Sheep	13	0.51	58
Erica arborea L.	Khlenj	Seed	De/Oral	OHP	Goats	17	0.51	67
Euphorbiaceae								
Euphorbia characias L.	Anaghou	Whole plant	De/Oral	EEP	Sheep	10	0.51	47
Euphorbia falcata L.	Hayat Nofos	Whole plant	De/Oral	RP	Goats	6	0.43	58
Euphorbia peplus L.	Laaya	Whole plant	De/Oral	EEP	Cows	7	0.54	67
Euphorbia segetalis L.	Lferbyoun	Leaf	Cr/Inhalation	OHP, EEP	Sheep	5	0.34	57
Mercurialis annua L.	Hrriyga Lmelsa	Whole plant	De/Oral	EEP	Mules	43	0.57	96
Ricinus communis L.	Kherouâ	Leaf	Gr/Massage	OHP	Donkeys	47	0.53	85
Fabaceae								
Acacia albida Delile	Chok Telh	Root	De/Oral	UP	Sheep	26	0.54	75
Adenocarpus decorticans Boiss.	Tumert	Whole plant	De/Oral	GI	Cats	10	0.51	64
Anthyllis vulneraria L.	Anafla	Leaf	Co/Inhalation	EEP	Goats	7	0.43	58
Astragalus depressus L.	Baklat lkettad	Leaf	In/Oral	GI	Goats, Sheep	6	0.36	75
Acacia raddiana Savi.	Talh	Leaf	Cr/Dermal	RP	Horses	40	0.45	65
Cassia senna L.	Sna Mekki	Bark	De/Oral	EEP	Sheep	15	0.51	48
Ceratonia siliqua L.	Salghwab	Fruit	Gr/Massage	EEP	Dogs	84	0.62	57
Cicer arietinum L.	Hommes	Seed	De/Oral	OHP	Cows, Goats	11	0.52	74
Glycyrrhiza glabra L.	Arq Sûs	Bark	De/Oral	EEP	Sheep	19	0.41	58
Lens culinaris Medik.	Aaddes	Seed	De/Oral	RP	Sheep	19	0.46	68
Lupinus angustifolius L.	Shenqalaa	Leaf	Cr/Inhalation	OHP	Goats	21	0.36	76
Lupinus pilosus L.	Rjel Djaja	Seed	Co/Massage	EEP	Sheep	12	0.51	57
Phaseolus aureus Roxb.	Soja	Seed	De/Oral	EEP	Goats	14	0.42	63
Phaseolus vulgaris L.	Loubya	Seed	Cr/Inhalation	OHP, EEP	Sheep	7	0.39	68
Pisum sativum L.	Jelbana	Seed	De/Oral	GI	Chickens	5	0.45	81
Medicago polymorpha L.	Fessa	Whole plant	De/Oral	EEP	Sheep	6	0.46	74
Medicago sativa L.	Fessa	Leaf	Gr/Massage	GI, D	Mules, Donkeys	92	0.65	57
Retama monosperma (L.) Boiss.	Rtem	Aerial parts	Cr/Dermal	D	Dogs	50	0.54	48
Retama raetam (Forssk.) Webb.	Rtem	Root	De/Oral	EEP		41	0.45	68
Trigonella foenum-graecum L.	Helba	Seed	Co/Inhalation	OHP, EEP	Goats, Sheep	95	0.81	100
Vicia faba L.	Elfûl	Seed	De/Oral	EEP	Chickens	86	0.34	59
Vicia benghalensis L.	Jelbanet Lehnouch	Leaf	Cr/Massage	GI	Sheep	7	0.41	57
Vicia sativa L.	Guersana	Whole plant	De/Oral	RP	Sheep	6	0.51	58
Vicia tenuifolia Roth.	Bykya	Leaf	In/Oral	OHP	Goats	5	0.37	64
Fagaceae								
Quercus coccifera L.	Al Qirmiz	Leaf	De/Oral	EEP	Sheep	27	0.36	67
Quercus faginea Lam.	Korrich	Leaf	Co/Massage	D	Cows	29	0.54	58
Quercus ilex L.	Lbellout akhdar	Leaf	In/Oral	OHP	Mules	22	0.51	100
Quercus lusitanica Lam.	Lbellout	Leaf	De/Oral	EEP	Sheep	14	0.61	57
Quercus rotundifolia Lam.	Tasaft	Leaf	Cr/Inhalation	RP	Horses, Mules	10	0.48	68
Quercus suber L.	Dbagh	Bark	Cr/Dermal	OHP	Donkeys	35	0.55	72
Geraniaceae								
Geranium robertianum L.	Ibrat Erraai	Leaf	De/Oral	UP	Sheep	5	0.47	64
Pelargonium capitatum (L.) L'Hér.	Laatercha	Aerial parts	De/Oral	GI	Dogs	17	0.52	58
Iridaceae								
Iris × *germanica* L.	Sawsan Almani	Aerial parts	De/Oral	EEP	Chickens	4	0.52	63
Juglandaceae								
Juglans regia L.	Guergaâ	Fruit	Gr/Inhalation	EEP	Sheep	9	0.43	56
Lamiaceae								57
Calamintha officinalis Moench	Manta	Whole plant	De/Oral	RP	Goats	14	0.54	48
Lavandula dentata L.	Lakhzama	Aerial parts	De/Oral	OHP	Sheep	80	0.69	81
Lavandula multifida L.	Kohhyla	Leaf	Cr/Massage	EEP	Cows	58	0.47	78
Lavandula officinalis Chaix.	Lkhzama	Flower	In/Oral	EEP	Goats	69	0.45	100
Lavandula pedunculata (Mill.) Cav.	Lakhzama	Leaf	Cr/Dermal	GI, EEP	Sheep, Goats	62	0.49	69
Lavandula stoechas L.	Halhal	Leaf	Co/Inhalation	EEP	Mules	93	0.52	77
Marrubium echinatum Ball.	Mrywt	Aerial parts	De/Oral	OHP	Sheep	49	0.43	70
Marrubium heterocladum Emb. & Maire	Mriwta	Leaf	Cr/Dermal	GI, EEP	Cats, Goats	12	0.38	66
Marrubium vulgare L.	Ifzi	Leaf	Cr/Inhalation	RP	Sheep	67	0.59	100
Melissa officinalis L.	Lbelsan	Leaf	De/Oral	EEP	Sheep	23	0.52	57
Mentha cervina L.	Menta	Whole plant	Gr/Dermal	EEP	Sheep	24	0.47	81
Mentha × *citrata* Ehrh.	Nana Elmeska	Whole plant	De/Oral	OHP	Horses	42	0.53	75
Mentha x piperita L.	Na'na El-Aabdi	Leaf	Gr/Massage	EEP, D	Sheep, Cows	36	0.54	58
Mentha pulgium L.	Fliyou	Whole plant	Cr/Dermal	D	Sheep	45	0.48	76
Mentha × *rotundifolia* (L.) Huds.	Mchichtrou	Leaf	In/Oral	GI	Cows	56	0.41	69
Mentha spicata L.	Na'a Na'a	Whole plant	De/Oral	EEP	Goats	41	0.39	58
Mentha suaveolens Ehrh.	Timersad	Leaf	Cr/Massage	GI	Donkeys	16	0.38	75
Ocimum basilicum L.	Lhbak	Aerial parts	Gr/Dermal	EEP	Sheep	64	0.58	83
Origanum compactum Benth.	Zaatar	Leaf	Cr/Massage	GI	Chickens	97	0.72	100
Origanum majorana L.	Mard'douch	Aerial parts	De/Oral	EEP	Sheep	73	0.48	75
Origanum vulgare L.	Zaatr Elma	Leaf	Co/Inhalation	GI	Mules	69	0.57	68
Rosmarinus officinalis L.	Azir	Leaf	Po/Massage	EEP	Goats	70	0.56	93
Salvia argentea L.	El Kouissa	Leaf	De/Oral	OHP	Cats	14	0.45	68

(*continued*)

Table 2 (*Continued*)

Family and scientific name	Vernacular name	Used parts	Method of preparation/ administration mode	Therapeutic uses	Animal species	UR	UV	FL
Salvia officinalis L.	Salmiya	Leaf	Cr/Inhalation	RP	Sheep	28	0.57	57
Satureja alpina (L.) Scheele	Zaaytra	Leaf	Cr/Dermal	OHP	Chickens	23	0.47	58
Thymus saturejoides Coss.	Z'itra	Leaf	Cr/Massage	EEP	Sheep	100	0.51	100
Thymus vulgaris L.	Zaitra	Leaf	Co/Dermal	GI	Goats	88	0.53	85
Vitex agnus-castus L.	Kharwae	Seed	De/Oral	RP	Sheep	42	0.47	48
Lauraceae								
Cinnamomum camphora (L.) J.Presl.	Kafour	Leaf	In/Oral	EEP, RP	Cows, Goats	10	0.51	67
Cinnamomum zeylanicum Blume.	Qarfa	Bark	Cr/Inhalation	GI	Donkeys	7	0.48	58
Laurus nobilis L.	Rend	Leaf	De/Oral	UP	Sheep	49	0.58	95
Persea gratissima C.F.Gaertn.	Avocat	Fruit	Gr/Dermal	OHP	Goats	5	0.50	57
Linaceae								
Linum usitatissimum L.	Zeri't Elkettan	Seed	De/Oral	EEP	Goats, Sheep	21	0.41	68
Lythraceae								
Lawsonia inermis L.	Henna	Leaf	De/Oral	EEP	Mules	25	0.47	74
Punica granatum L.	Remman	Fruit	Co/Massage	EEP	Sheep	63	0.49	85
Malvaceae								
Hibiscus sabdariffa L.	Karkadé	Leaf	In/Oral	RP	Dogs	8	0.50	69
Malva hispanica L.	Khobbeyza	Leaf	De/Oral	OHP	Sheep	14	0.41	72
Malva silvestris L.	Bakkula	Leaf	Cr/Dermal	D	Horses	20	0.54	64
Moraceae								
Ficus carica L.	Karmous	Leaf	Gr/Massage	EEP	Sheep	47	0.39	80
Morus alba L.	Tout Zarb	Fruit	Cr/Dermal	GI	Donkeys	12	0.54	71
Myristicaceae								
Myristica fragrans Houtt.	Bsibissa	Aerial parts	De/Oral	RP	Sheep	4	0.47	69
Myrtaceae								
Eucalyptus camaldulensis Dehnh.	Kalitûs	Leaf	In/Oral	EEP	Cows	7	0.57	84
Eucalyptus globulus Labill.	Kalitûs	Leaf	De/Oral	GI	Sheep	75	0.45	97
Eugenia caryophyllata Thunb.	Qronfel	Fruit	Cr/Inhalation	GI, EEP	Goats, Mules	24	0.53	57
Myrtus communis L.	Rayhan	Leaf	Co/Massage	EEP	Mules	53	0.50	57
Pimenta dioica (L.) Merr.	Nwiwira	Fruit	Cr/Dermal	GI	Sheep	5	0.45	68
Nitrariaceae								
Peganum harmala L.	El Harmel	Seed	De/Oral	EEP	Mules	65	0.58	71
Oleaceae								
Fraxinus angustifolia Vahl.	Lsan Ettir	Seed	De/Oral	GI	Sheep	20	0.39	75
Olea europea L.	Zaytoun	Leaf	Cr/Massage	D	Sheep	67	0.57	68
Olea europea var. *sylvestris* (Mill.) Lehr.	Zabbouj	Leaf	In/Oral	GI, EEP	Goats, Sheep	45	0.47	66
Papaveraceae								
Chelidonium majus L.	Bklat elkhatatif	Leaf	Cr/Dermal	OHP	Cows	1	0.51	74
Fumaria officinalis L.	Hchicht Essibyan	Root	De/Oral	EEP	Sheep	6	0.39	56
Glaucium flavum Crantz.	Merzak Halabi	Flower	Gr/Massage	GI	Goats	15	0.57	67
Papaver rhoeas L.	Bela'man	Flower	In/Oral	EEP	Horses	42	0.50	49
Pinaceae								
Abies marocana Trab.	Tannoub	Leaf	Cr/Massage	EEP	Mules	52	0.59	67
Cedrus atlantica (Endl.)	Arz	Leaf	De/Oral	GI	Sheep	72	0.47	58
Pinus pinaster Aiton.	Tayda	Bark	Cr/Massage	EEP	Donkeys	65	0.51	73
Pinus pinaster var. maghrebiana Villar.	Tayda	Leaf	Cr/Dermal	EEP, D	Goats, Sheep	12	0.53	75
Pinus nigra J.F.Arnold	Tighrou	Leaf	Cr/Inhalation	GI	Dogs	14	0.36	48
Pinus sylvestris L.	Sanouber	Bark	De/Oral	EEP	Sheep	52	0.54	67
Piperaceae								
Piper nigrum L.	Ibzar	Seed	Gr/Dermal	OHP	Horses	15	0.45	68
Plantaginaceae								
Digitalis purpurea L.	Dayl Ettaalab	Flower	Co/Massage	EEP	Sheep	2	0.61	44
Plantago lanceolata L.	Lssan lhamel	Flower	In/Oral	EEP	Goats	6	0.57	65
Poaceae								
Avena sativa L.	Khortal	Seed	De/Oral	UP	Sheep	48	0.54	69
Festuca rifana Litard. & Maire	Lkseb	Aerial parts	De/Oral	GI	Mules	25	0.46	57
Cymbopogon citratus (DC.) Stapf.	Aoshb Elhamed	Leaf	Cr/Massage	EEP	Cows, Sheep	6	0.45	67
Cynodon dactylon (L.) Pers.	N'jem	Rhizome	De/Oral	EEP	Mules	4	0.39	72
Hordeum vulgare L.	Chaâir	Seed	Po/Dermal	GI, EEP	Mules, Sheep	78	0.48	58
Oryza sativa L.	Rûz	Seed	De/Oral	EEP	Donkeys	46	0.46	69
Pennisetum glaucum (L.) R.Br.	Illane	Seed	De/Oral	GI	Chickens	36	0.54	58
Saccharum officinarum L.	Lkseb hlou	Whole plant	Cr/Massage	GI	Mules	18	0.54	48
Triticum aestivum L.	Lgamh	Leaf	Cr/Inhalation	RP	Sheep	17	0.58	65
Triticum turgidum L.	Zraa	Whole plant	De/Oral	GI, EEP	Goats, Mules	34	0.55	72
Polygonaceae								
Emex spinosa (L.) Campd.	Houmida	Aerial parts	In/Oral	RP	Sheep	7	0.47	68
Rumex acetosa L.	Lhoummad	Aerial parts	De/Oral	GI, RP	Goats, Mules	6	0.38	71
Rumex palustis Sm.	Tasmoumt	Leaf	Cr/Massage	EEP	Cows, Goats	8	0.47	47
Portulacaceae								
Portulaca oleracea L.	Rejla	Leaf	Gr/Dermal	EEP	Goats, Sheep	29	0.51	85
Ranunculaceae								
Clematis flammula L.	Nar Lbarda	Flower	Cr/Dermal	OHP	Goats	14	0.51	67

(*continued*)

Table 2 (*Continued*)

Family and scientific name	**Vernacular name**	**Used parts**	**Method of preparation/ administration mode**	**Therapeutic uses**	**Animal species**	**UR**	**UV**	**FL**
Helleborus foetidus L.	Lkarbak	Whole plant	De/Oral	RP	Mules	7	0.42	43
Nigella sativa L.	Sanûj	Seed	De/Oral	GI	Sheep	28	0.38	86
Ranunculus bullatus L.	Wden Elhallouf	Root	De/Oral	EEP	Cows	5	0.47	74
Ranunculus sceleratus L.	Zerhlil	Leaf	In/Oral	GI	Sheep	6	0.43	75
Rhamnaceae								
Ziziphus lotus (L.) Lam.	Nbeg	Fruit	Co/Inhalation	GI, EEP	Dogs	47	0.75	68
Rosaceae								
Crataegus monogyna Jacq.	Adamam	Leaf	De/Oral	EEP	Horses	5	0.58	71
Cydonia oblonga Mill.	Sfarjel	Leaf	Po/Massage	GI	Sheep	7	0.47	58
Eriobotrya japonica (Thunb.) Lindl.	Lemzah	Leaf	Cr/Dermal	EEP	Donkeys	10	0.54	67
Malus domestica Borkh.	Tûffah	Fruit	Cr/Massage	OHP	Goats	7	0.55	84
Prunus armeniaca L.	Mechmach	Leaf	Cr/Massage	D	Cows, Sheep	9	0.50	57
Prunus persica (L.) Batsch	Khokh	Fruit	Co/Dermal	GI	Goats	6	0.47	49
Rubus ulmifolius Schott.	Oualik	Leaf	Cr/Massage	EEP	Sheep	14	0.57	58
Rubiaceae								
Coffea arbica L.	Qahwa	Seed	De/Oral	GI	Horses, Mules	17	0.51	57
Galium aparine L.	Lsak	Leaf	Cr/Massage	RP	Chickens	5	0.36	68
Rubia peregrina L.	Fûwa	Root	De/Oral	GI, RP	Sheep, Mules	48	0.47	59
Rutaceae								
Citrus × *aurantium* L.	Larnej	Flower	In/Oral	EEP	Dogs	7	0.48	57
Citrus limetta Risso.	Lhamed Beldi	Fruit	Cr/Dermal	GI	Goats	8	0.57	58
Citrus limon (L.) Osbeck.	Lhamed	Fruit	Gr/Inhalation	GI	Sheep	5	0.53	68
Citrus reticulata Blanco.	Lmandarine	Fruit	Cr/Massage	D	Chickens	9	0.44	66
Citrus sinensis (L.) Osbeck.	Limoun	Fruit	Cr/Dermal	OHP	Cats	14	0.57	72
Ruta montana (L.) L.	Fijel	Aerial parts	De/Oral	GI, EEP	Goats, Sheep	57	0.39	76
Salicaceae								
Populus alba L.	Sefsaf	Leaf	De/Oral	GI, EEP	Goats, Sheep	58	0.54	74
Populus nigra L.	Sefsaf	Leaf	Cr/Dermal	D	Cows, Goats	40	0.42	59
Schisandraceae								
Illicium verum Hook.f.	Badiana	Aerial parts	In/Oral	EEP	Dogs	5	0.38	67
Scrophulariaceae								
Verbascum sinuatum L.	Torah	Flower	Po/Massage	GI	Sheep	8	0.48	58
Solanaceae								
Atropa baetica Willk.	Bleydour	Leaf	Co/Massage	RP	Mules	6	0.47	72
Atropa belladonna L.	Tatourah	Root	De/Oral	EEP	Sheep	15	0.51	59
Capsicum annuum L.	Tahmira	Fruit	Gr/Dermal	GI	Sheep	12	0.38	57
Capsicum frutescens L.	Sudaniya	Fruit	Cr/Inhalation	EEP	Sheep	4	0.47	67
Datura stramonium L.	Chedak Jmal	Seed	De/Oral	GI, UP	Chickens, Mules	13	0.42	74
Lycium europaeum L.	Haded Europa	Leaf	In/Oral	EEP	Sheep	5	0.37	58
Mandragora autumnalis Mill.	Bid Al Ghol	Leaf	Po/Massage	GI	Goats	46	0.62	59
Nicotiana glauca Graham.	Tembak Berri	Flower	De/Oral	EEP	Donkeys	18	0.47	70
Solanum lycopersicum L.	Maticha	Aerial parts	De/Oral	RP	Mules	8	0.57	57
Solanum melongena L.	Denjal	Fruit	Po/Dermal	GI	Sheep	5	0.45	58
Solanum nigrum L.	Buqnina	Leaf	Co/Massage	OHP	Cows	4	0.38	59
Solanum sodomaeum Dunal.	Tfah Lfar	Fruit	De/Oral	EEP	Sheep	4	0.48	58
Solanum tuberosum L.	Batâta	Leaf	De/Oral	EEP	Goats	8	0.57	67
Withania frutescens (L.) Pauquy.	Ali Amlal	Leaf	In/Oral	GI, EEP	Goats, Sheep	18	0.63	78
Tamaricaceae								
Tamarix aphylla (L.) H.Karst.	Adba	Leaf	Cr/Inhalation	RP	Goats	4	0.41	64
Tamarix gallica L.	Tamimayt	Leaf	Po/Massage	GI	Sheep	5	0.37	73
Tamarix ramosissima Ledeb.	Athel	Leaf	De/Oral	GI	Horses	6	0.58	49
Taxaceae								
Taxus baccata L.	Sanawbar Barri	Leaf	Po/Dermal	GI	Sheep	13	0.38	82
Theaceae								
Camellia sinensis (L.) Kuntze.	Atây	Leaf	Co/Massage	EEP	Goats	25	0.40	76
Thymelaeaceae								
Thymelaea virgata (Desf.) Endl.	Matnane	Leaf	De/Oral	EEP	Sheep	10	0.37	70
Urticaceae								
Urtica dioica L.	Hriga	Leaf	Cr/Massage	D	Goats	21	0.55	69
Urtica urens L.	Lhurriga	Leaf	De/Oral	GI, UP	Cows, Goats	14	0.52	75
Verbenaceae								
Aloysia citrodora Palau.	Lwiza	Leaf	In/Oral	OHP, EEP	Goats, Sheep	67	0.45	94
Lantana camara L.	Nabat Oum Kaltoum	Leaf	Po/Dermal	EEP	Sheep	5	0.54	74
Vitaceae								
Vitis vinifera L.	Aneb	Leaf	De/Oral	RP	Goats	16	0.37	58
Violaceae								
Viola arborescens L.	Banafsajia	Flower	Gr/Dermal	GI, EEP	Goats, Sheep	5	0.50	65
Viola canina L.	Banafsaj lkilab	Leaf	Cr/Inhalation	EEP	Sheep	4	0.35	54
Xanthorrhoeaceae								
Asphodelus cerasiferus J.Gay	Inghri	Bulb	In/Oral	UP	Sheep	19	0.49	57
Asphodelus microcarpus Salzm. & Viv.	Lberwag	Bulb	Po/Dermal	EEP	Dogs	7	0.52	82
Zingiberaceae								

(*continued*)

Table 2 (*Continued*)

Family and scientific name	**Vernacular name**	**Used parts**	**Method of preparation/ administration mode**	**Therapeutic uses**	**Animal species**	**UR**	**UV**	**FL**
Alpinia officinarum Hance.	khodenjal	Rhizome	De/Oral	EEP	Mules	14	0.51	75
Curcuma Longa L.	Kharqûm	Rhizome	Co/Massage	OHP	Sheep	13	0.36	64
Elettaria cardamomum (L.) Maton.	Qaaqella	Seed	De/Oral	GI, EEP	Cows, Goats	8	0.47	68
Zingiber officinale Roscoe.	Skinjbir	Rhizome	De/Oral	RP	Goats	60	0.57	100
Zygophyllaceae								
Tribulus terrestris L.	Ders Elajouz	Aerial parts	Cr/Dermal	GI	Goats, Sheep	7	0.54	55

EEP: Endo and ecto parasitic,**OHP:** Other health problems, **GI:** Gastro-intestinal, **D:** Dermatological,**UP:** Urinary problems, **RP:** Respiratory problems, **Co:** Cooking, **Cr:** Crushing, **De:** Decoction, **In:** Infusion, **Gr:** Grinding, **Po:** Powder.

important, whereas they will be near zero if there are few reports related to its use.

2.6.3. Fidelity level (FL)

Fidelity level (FL) is the percentage of informants, who claim the use of a specific species for the same major use, which can be carried out through fidelity level formulated by (Alexiades, 1996). FL $(\%) = \frac{Np}{N}$ X 100. Where Np is the number of participants who reported the use of a plant for a specific purpose and N is the sum of participants who claimed the use of the plant for any purpose. A high level of FL reflects the high use of plant species in specific diseases in the study area.

2.6.4. Relative popularity level (RPL)

Relative popularity level (RPL) is the ratio between several ailments treated by a particular plant species and the total number of informants for any disease. However, plant species with comparable FL may vary in their healing potential. A correction scale is therefore introduced, in which all the encountered plant species are divided into popular and unpopular groups. The relative popularity level (RPL) assumes a value of 0 and 1, with "1″ being the complete popularity of a plant for major ailments and "0″ no ailments treated by a plant species (Majeed et al., 2020). The relative popularity level (RPL) of the plant species is calculated and designated as popular or unpopular. For popular plant species, RPL was arbitrarily selected equal to 1 that represents the complete popularity of a species for the cure of ailments and 0 value represents that no ailment was treated by this species (Umair et al., 2017).

2.6.5. Rank order priority (ROP)

Rank order priority (ROP) is a correction factor, used for appropriate ranking of the plant species with various FL and RPL values. The ROP or the corrected FL values for the medicinal plants were calculated by (ROP = FL x RPL) according to Friedman et al. (Friedman et al., 1986).

2.6.6. Jaccard index (JI)

The Jaccard Index (JI), also known as the Jaccard Similarity Coefficient, is a measurement that is used to compare study data with that of other ethnobotanical studies conducted in other parts of Morocco as well as other countries in the world, and also among the indigenous communities in the studied areas. JI is calculated using the following formula (González-Tejero et al., 2008): JI = c x$\frac{100}{a+b-c}$. Where, a represent the number of plants in an area A, b is the number of plants in area B and c is the number of plants common to area A and B.

2.6.7. Informant consensus factor (ICF)

To determine common species used and homogeneity of use in various areas, we calculated the informant consensus factor (ICF). ICF values close to one indicates that there is homogeneity in the use of medicinal plants between the informants, while ICF values close to 0 suggest that there is little or no exchange of knowledge between informants (Heinrich et al., 2009). ICF value can be calculated by the formula: ICF = $\frac{Nur-Nt}{Nur-1}$. Where Nur is the number of use reports in a particular category and Nt is the number of species that were used as medicine in a particular category. In this analysis, we tested whether knowledge is shared between the localities inhabited by the people of Rif.

3. Results

3.1. Taxonomic classification of plant species

In total, 300 medicinal plant species belonging to 205 genera and 67 families were documented, which were used to treat various types of livestock ailments by local people of Rif, classified into 4 major disease categories as indicated in (Table 2). The most represented families were Asteraceae, Lamiaceae, Fabaceae, Apiaceae with 33, 28 24, and 18 species, respectively, followed by Solanaceae with 14 species, Brassicaceae 11 species, Poaceae 10 species, and Asparagaceae 9 species.

3.2. Parts used of medicinal plants

In this study, the most used plant parts in popular medicinal recipes were leaves (PPV=48.4%, 3 872 citations, 131 species), followed by seeds (PPV=13.46%, 1 078 citations, 35 species), aerial parts (PPV=11.7%, 936 citations, 37 species), whole plant (PPV=8.6%, 690 citations, 27 species), fruits (PPV=6.4%, 509 citations, 28 species), bulbs (PPV=4.2%, 336 citations, 7 species), flowers (PPV=3.3%, 264 citations, 16 species), roots (PPV=2.8%, 225 citations, 9 species), and rhizomes (PPV=1.14%, 91 citations, 4 species), respectively.

3.3. Toxicity of medicinal plant species

In this investigation, the reported ethnoveterinary data are generally confined to medicinal usage, with some information on the toxicity of plant species. Only 25% of the medicinal plants were documented as having some toxic effects such as *Datura stramonium* L., *Mandragora autumnalis* Mill., *Peganum harmala* L., *Ricinus communis* L., *Solanum sodomaeum* Dunal., *Lactuca virosa* Habl., and *Drimia maritima* (L.) Stearn. The majority of the informants stated that they use plant species based on the experience of the elders among them, so they do not believe that the plants are toxic.

3.4. Methods and conditions of remedy preparation

Medicinal plants can be used for preparing herbal remedies through different methods, depending on the plant part utilized and animal condition (Table 2). The decoction was the most common method of drug preparation (45.15%), followed by crushing (22.7%), cooking (10.2%), grinding (9.9%), infusion (8.9%), and powder (3.15%). The preparation of herbal medicine needs ingredients and solvents. The major solvent was water, but butter, honey, and oils were also widely used ingredients. The fresh and dried materials of traditional medicinal plant remedies were prepared by informants in the study area. The highest (65%) number of remedies were prepared from fresh parts of medicinal plants only followed by a fewer number of

Table 3
Categories of diseases with ICF value, number of taxa, and use reports.

Diseases category	Number of taxa used	Number of use reports	ICF Value
Dermatological	25	827	0.971
Gastro-intestinal	86	2 520	0.967
Urinary problems	14	384	0.966
Other health problems	49	1 259	0.962
Endo and ecto parasitic	120	3 046	0.961
Respiratory problems	48	1 115	0.958

herbal plant medicines (20%) prepared from the dried plant parts only, and 15% of remedies were prepared either from fresh or dry medicinal plant parts.

3.5.Mode. of administration

Local communities of Rif employ several modes of administration of plant material for medicinal use including internal and external routes. The most frequently used mode of remedy administration is oral that accounted for 53%, followed by massage (21.2%), dermal (14.6%), and inhalation (11.2%).

3.6. Species of animals treated

In this study, a total of 11 animal species were ranked and cited according to the importance of the indigenous communities of Rif (Table 2). Sheep were the most commonly treated animals (3 624 citations with 130 medicinal plants), followed by goats (2 081 citations, 78 medicinal plants), mules (1 099 citations, 37 medicinal plants), cows (811 citations, 31 medicinal plants), horses (15 medicinal plants, 272 citations), donkeys (8 medicinal plants, 185 citations), Donkeys (603 citations, 21 medicinal plants), chickens (442 citations, 17 medicinal plants), cats (401 citations, 10 medicinal plants,), horses (273 citations, 13 medicinal plants), and dogs (268 citations, 12 medicinal plants).

3.7. Category of diseases affecting livestock in the Rif

Indigenous people of Rif used 300 medicinal plants to treat various health diseases in livestock (Table 3). The 9 151 use reports were classified into 6 health diseases categories following the International Classification of Primary Care classification system (ICPC) (Lamberts and Wood, 1987). Most use records were in the category dermatological diseases (827 use reports; 25 plant species; ICF=0. 971), followed by gastro-intestinal diseases (2 520 use reports; 86 plant species; ICF=0.967), urinary problems (384 use reports; 14 plant species; ICF=0.966), other health problems (1 259 use reports; 49 plant species; ICF=0.962), and endo and ecto parasitic (3 046 use reports; 120 plant species; ICF=0.961). The least ICF was associated with respiratory problems (1 115 use reports; 48 plant species; ICF=0.958).

3.8. Use value (UV)

The UV index authenticates the use report of a plant species used for various diseases. In the present research, the UV of the reported medicinal plant species varied from 0.27 to 0.83 (Table 2). The highest UV was calculated for *Chenopodium ambrosioides* L. (UV=0.83), *Trigonella foenum-graecum* L. (UV=0.81), *Atractylis gummifera Salzm.* ex L. (UV=0.78), and *Tetraclinis articulata* (Vahl) Mast. (UV=0.76). However, the low citation species and their respective values were *Calendula arvensis* M.Bieb. (UV=0.29), *Sinapis alba* L. (UV=0.28), and *Daucus carota* L. (UV=0.27).

3.9. Fidelity level (FL)

This study showed twenty medicinal plant species having high FL values (FL% > 87). The fidelity level of these most important medicinal plants ranged from 87% to 100%. *Asparagus officinalis* L., *Citrullus colocynthis* (L.) Schrad., *Tetraclinis articulata* (Vahl) Mast., *Trigonella foenum-graecum* L., *Quercus ilex* L., *Lavandula officinalis* Chaix., *Marrubium vulgare* L., *Origanum compactum* Benth., *Thymus saturejoides* Coss., and *Zingiber officinale* Roscoe. show a 100% fidelity level for general health, infectious diseases, internal parasites, and external parasites (see Table 2). Other medicinal plants with high FL values were: *Eucalyptus globulus* Labill. (FL=97% for general health), *Mercurialis annua* L. (FL=96% for internal parasites), *Laurus nobilis* L. (FL=95% for infectious diseases), *Aloysia citrodora* Palau. (FL=94% for general health), *Rosmarinus officinalis* L. (FL=93% for internal parasites), *Juniperus phoenicea* L. (FL=92% for general health), *Opuntia ficus indica* (L.) Mill. (FL=91% for general health), *Cannabis sativa* L. (FL=90% for infectious diseases), *Allium sativum* L. (FL=89% for general health), and *Artemisia mesatlantica* Maire. (FL=87% for internal parasites).

3.10. Relative popularity level and rank order priority of plant species

The separating line between the popular and unpopular groups falls at the point where an average number of uses per medicinal plant disease increase with a further increase in the number of informants. About seven medicinal plant species mentioned by 60 informants were grouped as unpopular whereas, thirteen plant species reported by 102 or more informants were classified as popular. Medicinal plants with a high popularity level were *Aloysia citrodora* Palau. (RPL=1.15), *Opuntia ficus indica* (L.) Mill. (RPL=1.10), and *Trigonella foenum-graecum* L. (RPL=1.05). The correlation between the numbers of informants who claimed the use of certain plant species for a particular disease is given in Fig. 2.

Out of twenty plant species, only 3 attained 100% or above ROP values. *Aloysia citrodora* Palau., *Trigonella foenum-graecum* L., and *Opuntia ficus indica* (L.) Mill. were reported with the highest ROP value (≥100%), followed by *Marrubium vulgare* L. (ROP=70), *Artemisia mesatlantica* Maire. (ROP=66), *Lavandula officinalis* Chaix. (ROP=62), and *Juniperus phoenicea* L. (ROP=66). The rest of the species presented less than 57% of ROP values Table 4.

3.11. Jaccard index (JI)

The Jaccard Index was performed to develop a comparison between this study and previously reported studies by botanists, one from other regions of Morocco and another from outside Morocco. The original application information of ethnomedicinal plants within our study was compared with ten previous ethnobotanical research studies published from various countries, including Morocco. The Jaccard index was calculated for five regions of Morocco and five regions from outside of Morocco with the JI ranged from 3.7% to 73.1% (Table 5). The highest JI index (JI=73.1%) was found with a previous report from the Rif, Northern Morocco (N. Chaachouay et al., 2021b), followed by the study conducted in Jordan (Al-Quran, 2008) with JI=35.8%, Central High Atlas, Morocco (El Alami and Chait, 2017) with

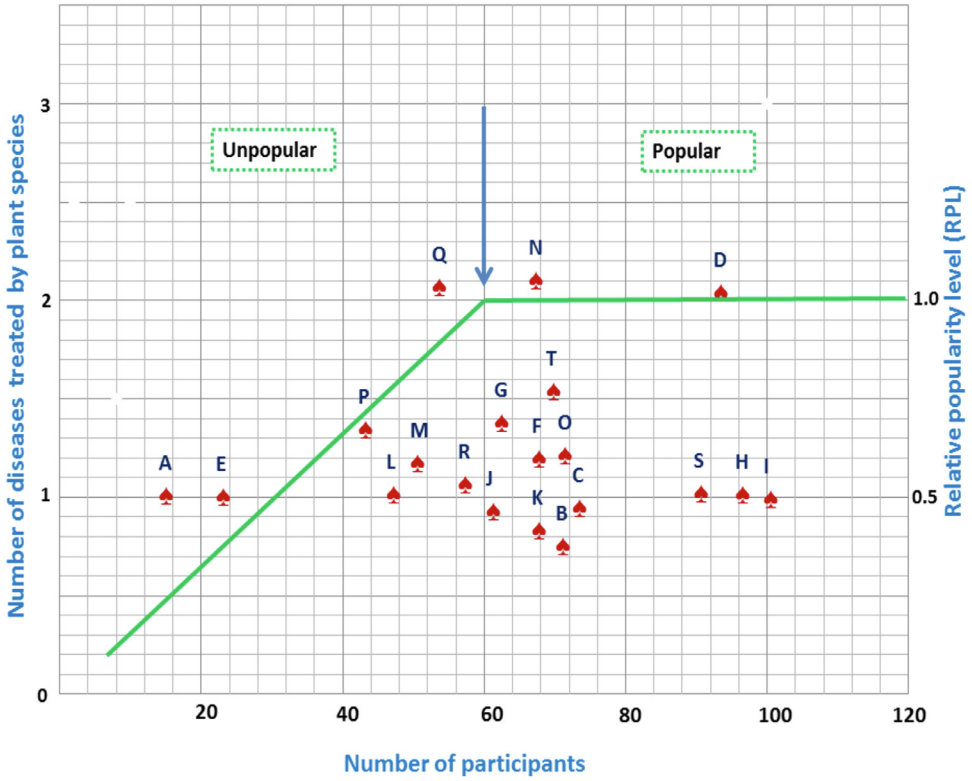

Fig. 2. Correlation between the numbers of informants claimed the use of 20 plant species for a particular disease.

Table 4
Highly utilized plant species with major diseases, FL, RPL, and ROP.

Medicinal plant species		Major diseases	FL	RPL	ROP
A	*Asparagus officinalis* L.	General health	100%	0.50	50
B	*Citrullus colocynthis* (L.) Schrad.	Internal parasites	100%	0.38	38
C	*Tetraclinis articulata* (Vahl) Mast.	Internal parasites	100%	0.48	48
D	*Trigonella foenum-graecum* L.	General health	100%	1.05	105
E	*Quercus ilex* L.	General health	100%	0.50	50
F	*Lavandula officinalis* Chaix.	External parasites	100%	0.62	62
G	*Marrubium vulgare* L.	Infectious diseases	100%	0.70	70
H	*Origanum compactum* Benth.	General health	100%	0.50	50
I	*Thymus saturejoides* Coss.	Internal parasites	100%	0.49	49
J	*Zingiber officinale* Roscoe.	Infectious diseases	100%	0.47	47
K	*Eucalyptus globulus* Labill.	General health	97%	0.38	36
L	*Mercurialis annua* L.	Internal parasites	96%	0.50	48
M	*Laurus nobilis* L.	Infectious diseases	95%	0.60	57
N	*Aloysia citrodora* Palau.	General health	94%	1.15	108
O	*Rosmarinus officinalis* L.	Internal parasites	93%	0.62	57
P	*Juniperus phoenicea* L.	General health	92%	0.66	60
Q	*Opuntia ficus indica* (L.) Mill.	General health	91%	1.10	100
R	*Cannabis sativa* L.	Infectious diseases	90%	0.52	46
S	*Allium sativum* L.	General health	89%	0.51	45
T	*Artemisia mesatlantica* Maire.	Internal parasites	87%	0.76	66

FL: Fidelity level; **RPL:** Relative popularity level; **ROP:** Rank order priority.

JI=31.1%, Natural Regional Park, Rif of Morocco (Hachi et al., 2015) with JI=25.1%, High Atlas Central of Morocco (Belhaj et al., 2021) with JI=23%, North-East of Morocco (Hassani et al., 2013) with JI=19.1%, Nuoro, Sardinia, Italy (Bullitta et al., 2018) with JI=10.1%, West Bank, Palestine (Ali-Shtayeh et al., 2016) with JI=9.5%, and Dindigul district, Tamilnadu, India (Sivasankari et al., 2014) with JI=5.5%. The lowest JI such as 3.7% was recorded from Azad Jammu and Kashmir, Pakistan (Amjad et al., 2017).

3.12. Comparison with studies in neighboring Rif and outside of Morocco

This study shares the greatest number of common plant species (245) with the study from the Rif, north of Morocco that reported a total of 280 plant species (N. Chaachouay et al., 2021b) with 133 plant species having similar uses and 112 plant species having dissimilar uses. Similarly, 112 medicinal plants were common between our study and a study from Central High Atlas, Morocco (El Alami and Chait, 2017) with 34.3% similar uses and 30.8% dissimilar uses. 83 plant species, in our study, were found common to the studies reported from Central High Atlas, Morocco (Belhaj et al., 2021). Other studies from Natural Regional Park, Rif of Morocco (Bachar et al., 2016), and North-East of Morocco (Hassani et al., 2013), share 81 and 67 medicinal plant species common to our study respectively (Table 5).

In the comparison of this investigation with other studies from outside of Morocco, the percentage of similarity ranged from 6.6% to 51.3% (Table 5). The highest degree of similarity was observed in

Table 5
Comparison between our study and other studies from Morocco, and outside Morocco.

Study area	Journal name	Citation and studyyear	Total reported species	Plants with dissimilar use	% of dissimilar uses	Plants with similar use	% of plant with similar uses	Plant senlistedonly instudy area	Plant senlistedonly inalignedareas	Total species common inboth area	JI
Rif, Northern Morocco	*AJSE*	(N. Chaachouay et al., 2021b)	280	112	40	133	47.5	55	35	245	73.1
Central High Atlas, Morocco	*Alger J Nat Prod.*	(El Alami and Chait, 2016)	172	53	30.8	59	34.3	188	60	112	31.1
Natural Regional Park, Rif of Morocco	*J. Mater. Environ. Sci.*	(Bachar et al., 2016)	104	41	39.4	40	38.5	219	23	81	25.1
High Atlas Central of Morocco	*JPPRes*	(Belhaj et al., 2021)	144	76	52.8	68	47.2	217	61	83	23
North-East of Morocco	*Ethnopharmacologia*	(HassaniM et al., 2013)	117	35	29.9	32	27.4	233	50	67	19.1
Jordan	*J Nat Prod*	(Al-Quran, 2008)	315	72	22.9	90	28.6	138	162	162	35.8
Nuoro, Sardinia, Italy	J. Ethnobiol. Ethnomedicin.	(Signorini et al., 2009)	72	12	16.7	22	30.6	266	38	34	10.1
West Bank, Palestine	*J. Ethnopharm.*	(MS Ali-Shtayeh et al., 2016)	138	15	9.2	23	16.7	262	100	38	9.5
Dindigul district, Tamilnadu, India	*J. Ethnopharm.*	(Sivasankari et al., 2014)	139	7	5	16	11.5	277	116	23	5.5
Azad Jammu and Kashmir, Pakistan	Plos one	(Amjad et al., 2017)	121	7	5.8	8	6.6	285	106	15	3.7

Nuoro, Sardinia, Italy (Bullitta et al., 2018) with SU=30.6%, and Jordan (Al-Quran, 2008) with SU=28.6%. The Jaccard index was also calculated for comparing the study area with the overall study area, the JI ranged from 3.7% to 35.8%. The highest JI index was found with a previous report from Jordan (Al-Quran, 2008) with JI=35.8%, Nuoro, Sardinia, Italy (Bullitta et al., 2018) with JI=10.1%, West Bank, Palestine (Ali-Shtayeh et al., 2016) with JI=9.5%, and Dindigul district, Tamilnadu, India (Sivasankari et al., 2014) with JI=5.5%. The lower JI index such as JI=3.7% was found with the study conducted in Azad Jammu and Kashmir, Pakistan (Amjad et al., 2017).

4. Discussion

This research is focused on ethnoveterinary use of medicinal plant species which was analyzed on the ground of data obtained through the indigenous people of Rif. Ethnoveterinary remedies in the Rif area comprise 300 plant species belonging to 205 genera and 67 families. The families most mentioned by the informants were Asteraceae with 33 species (11%), Lamiaceae with 28 species (9.33%), and Fabaceae with 24 species (8%). This is probably because of the abundance of these families in the Mediterranean flora, but it is also worth noting that they include many plants commonly used by the indigenous people of Rif as food and natural medicine. Therefore, medicinal flora is dominated mainly by Asteraceae and Lamiaceae, which are among the main families of the spontaneous flora of Moroccan Rif, with a large number of species. Mediterranean studies show that Asteraceae and Lamiaceae are used in popular medicine (N. Chaachouay, et al., 2019; N. Chaachouay et al., 2019, 2020; Chaachouay et al., 2021b; Chaachouay and Zidane, 2021b; Merzouki et al., 2000). They are also the predominant family of natural medicine in district Mastung of Balochistan province-Pakistan (Bibi et al., 2014). This agrees with other ethnobotanical studies carried out in Morocco and other countries (Ahmad et al., 2018; Ali-Shtayeh et al., 2000; N. Chaachouay et al., 2020; Islam et al., 2006; Ugulu et al., 2009; Zougagh et al., 2019).

The most used plant parts were leaves (PPV=48.4%, 3 872 citations, 131 species), followed by seeds (PPV=13.46%, 1 078 citations, 35 species), aerial parts (PPV=11.7%, 936 citations, 37 species). It is thought that leaves contain more easily extractable phytochemicals, crude drugs, and many other mixtures that may be proven as valuable in phytotherapy (Ahmad et al., 2014; Bano et al., 2014). Note that the prevailing role of leaves is a habitual result in ethnobotanical studies on medicinal plant species carried out in Morocco (Belhaj et al., 2021; N. Chaachouay et al., 2019, 2019, 2020; N. Chaachouay et al., 2020, 2021a; N. Chaachouay et al., 2021; Chaachouay and Zidane, 2019; El Alami and Chait, 2016; Hassani et al., 2013; Chaachouay, Douira and Zidane, 2021a) and other parts of the world (Ali-Shtayeh et al., 2016; Amjad et al., 2017; Majeed et al., 2020; Ramana, 2008; Sivasankari et al., 2014; Umair et al., 2017). The preference for the use of leaves in the preparation of herbal medicines by the healers is likely due to the year-round availability of leaves, and the fact that they are easier to process, collect, store, and handle. Therefore, the leaves are natural food for some animals and they are also eaten for self-medication. Leaves and seeds are the renewable parts of the plant and their collection does not result in fatality.

The results showed that the majority of remedies were prepared from decoction. These results show that the local population believes in decoction mode and found it suitable for heating the body and disinfecting the plants (Lahsissene et al., 2009). On the other hand, the decoction provides assemble the greatest for the active constituents and attenuates or eliminates the toxic effect of some compounds. The decoction was the most common traditional remedy method that is used to treat the ailment, who prepare plant parts by mixing them with water, tea, or soup (N. Chaachouay, et al., 2019; Chaachouay and Zidane, 2021a; Orch et al., 2021) and in other countries (Ahmad et al.,

2014; Chalouan et al., 2008; Mosaddegh et al., 2016; Mussarat et al., 2014; Umair et al., 2017; Vickers, 2017). Oral mode of administration is a preferred route total across the globe (Andrade et al., 2017; Betti, 2003; N. Chaachouay et al., 2019, 2021b; N. Chaachouay et al., 2021; Jorim et al., 2012; Yirga and Zeraburk, 2011). The majority of indigenous people prepared remedies that were applied mostly orally. The administration of oral treatment may be defined by a high degree of internal illnesses in the region (Polat and Satıl, 2012).

In the Rif, 6 health diseases categories were reported to be treated by 300 medicinal species. ICF values obtained for the reported categories indicate the degree of shared knowledge for the uses of medicinal herbs. The informant consensus factor (ICF) of medicinal plants in our study ranges from (0.958–0.971). Most use records were in the category dermatological diseases (ICF=0.971), followed by gastrointestinal diseases (ICF=0.967) and urinary problems (ICF=0.966). The least ICF was associated with respiratory problems (ICF=0.958). Ethnopharmacological studies have shown that in some parts of the world, internal parasites are a first use category (Ghasemi et al., 2013; Masika and Afolayan, 2003; Megersa et al., 2013; Teklehaymanot and Giday, 2007). High ICF values can be used to pinpoint interesting species in search of bioactive compounds (Canales et al., 2005). Besides, this is consistent with the statement that traditional pharmaceutical products are usually limited to the treatment of mild and chronic diseases (Reuter, 1991). Meanwhile, the lowest ICF was found in dental pains and fever showing less or no consensus of using plants against these diseases. The lowest ICF may be due to the unavailability of information in study participants. In addition, low values are associated with many plant species with almost equal or high use reports suggesting a lower level of agreement among the informants on the use of these plant species to treat a particular disease category (Amjad et al., 2017).

Use-value reflects the importance of medicinal plants in terms of their traditional use in the study area. In our study, UV ranges from 0.27 to 0.83. The highest use values were reported for *Chenopodium ambrosioides* L. (UV=0.83), *Trigonella foenum-graecum* L. (UV=0.81), and *Atractylis gummifera* Salzm. ex L. (UV=0.78). Most of these medicinal plants were frequently used by the Rifain tribals in the Rif for the treatment of various ailments (N. Chaachouay et al., 2021b). All plants showed a high UV when used for exogenous diseases, such as infectious and parasitic diseases (e.g., cholera, ectoparasites, endoparasites, dysentery, measles, jaundice, chickenpox, rabies, anthrax, sheeppox, goatpox, foot-and-mouth disease, listeriosis), poisoning, injury, and certain other consequences of external causes (e.g., cuts and wounds) or general health (e.g., swellings, general weakness, anorexia, sore eyes, pediculosis, skin eruptions). The positions of these plant species correspond to the fact that they were reported by a maximum number of informants, therefore having a high use report (UR). These plant species are native to the Rif and have been known to local cultures over a long period. These results are important as they could form an important research baseline for subsequent evaluation of plant-derived medicinal compounds, potentially resulting in future drug discoveries (Mukherjee et al., 2012). The least use values were reported for *Calendula arvensis* M.Bieb. (UV=0.29), *Sinapis alba* L. (UV=0.28), and *Daucus carota* L. (UV=0.27) may be due to less accessibility and minimum ethnobotanical uses. It is found that plants having more use reports (UR) always have high UVs while those plants having fewer URs reported by informants have lower UV.

In this investigation, ten medicinal species of plants were recorded with a 100% fidelity level for a different type of diseases category. The medicinal plants having the highest FL constitute those are the most preferred plants among the informants in the treatment of particular illness category (Friedman et al., 1986). Some important plants with the highest FL in the study were *Asparagus officinalis* L., *Citrullus colocynthis* (L.) Schrad., *Tetraclinis articulata* (Vahl) Mast., and *Trigonella foenum-graecum* L. The plants with the highest FL are those reported to be most useful (Chattopadhyay et al., 2011; Ignacimuthu and Shanmugam, 2010; Pandikumar et al., 2011). Hence the plants with the highest FL might be an indication of their good healing potential for a specific ailment (Ayyanar and Ignacimuthu, 2011). The plant with the lowest FL indicates these plants were less preferred species for treating specific ailments. On the other hand, plant species with low FL infer that they were less preferred. In contrast, one of the highly reported medicinal plants (*Digitalis purpurea* L.) of this study has been widely used against various types of diseases and attained very low FL values as fleas, mites, Demodex mange, scabies, ear mites, and lice. Also, plants with low FL% should not be abandoned as dwindling to remark them to the future generation that it could increase the risk of the gradual disappearance of the knowledge (Chaudhary et al., 2006).

The 500 informants of Rif cited 300 medicinal plants for 4 various illness categories. Of them, 20 plant species received more consideration from our informants interviewed during this study. The rest of the 280 species were reported by fewer than 5 informants and therefore were excluded for further discussion. Medicinal species with high relative popularity levels were: *Aloysia citrodora* Palau. (RPL=1.15), *Opuntia ficus indica* (L.) Mill. (RPL=1.10), and *Trigonella foenum-graecum* L. (RPL=1.05). The high popularity of these plant species might be attributed to their high efficacy and the awareness of indigenous peoples which specifies their use as herbal medicine (Umair et al., 2017). The separating line between the popular and unpopular groups falls at the point where an average number of uses per plant cease to increase with a further increase in the number of informants. *Aloysia citrodora Palau.*, and *Trigonella foenum-graecum* L. were the popular plant species with RPL values RPL=1.15 and RPL=1.05 respectively. The healing potential of each species may vary and is expressed by its FL value (Umair et al., 2017).

Considering the ROP is a local variable because the local culture associated with a typical ecosystem determines the ROP of medicinal plants then this is a parameter that we cannot globalize. This study revealed that *Aloysia citrodora* Palau. (ROP=108), *Trigonella foenum-graecum* L. (ROP=105), and *Opuntia ficus indica* (L.) Mill. (ROP=100) had the highest values of ROP, which means that these plant species are the most important medicinal plants for ethnoveterinary practices of indigenous people of Rif. Moreover, this is probably due to decreasing popularity of herbal medicines among the local communities of the study area. While medicinal species such as *Citrullus colocynthis* (L.) Schrad. (ROP=38) and *Eucalyptus globulus* Labill. (ROP=36) had a lower priority among medicinal plants used by the local population.

The results of the present investigation were compared with those from 10 national and international studies conducted in other areas similar in terms of their similar vegetation, cultural values, and climatic conditions to the Rif area. In a comparison of this study with other studies from Morocco and outside of Morocco, the JI ranged from 73.1% to 3.7%. The data show that across 123 medicinal plants, the similarity percentage ranges 33.33 from 4.62 while the dissimilarity percentage ranges from 3.7 to 73.1. The highest degree of similarity index was with studies conducted in Moroccan Rif (N. Chaachouay et al., 2021b) with JI=73.1%, Jordan (Al-Quran, 2008) with JI=35.8%, and Central High Atlas, Morocco (El Alami and Chait, 2016) with JI=31.1%. It has been reported that neighboring indigenous communities share the more common natural practice of plants as medicines to treat various diseases and this is because of more social trade and sharing of ethnoveterinary knowledge among native ethnics (Esakkimuthu et al., 2018). In general, the high degree of similar types of plant uses may indicate the same cultural practices among local people, and similar types of vegetation may reflect the same type of floral diversity and climate in those studies areas. The lowest JI values were for the studies conducted in the Dindigul district, Tamilnadu, India (Sivasankari et al., 2014) with JI=5.5% and Azad Jammu and Kashmir, Pakistan (Amjad et al., 2017) with JI=3.7%. These

studies were carried out at a greater distance from our study location, and thereby reflect a greater difference in ethnoveterinary knowledge due to differences in population size, species diversity, and habitat structure. Furthermore, geological isolation of ethnic groups and plants resulted in a significant change in vegetation structure and therapeutic uses of indigenous plants and this may be a reason for the loss of ethnobotanical information (Ali-Shtayeh et al., 2011; Ali-Shtayeh et al., 2011; Jain, 1977; Majeed et al., 2020).

5. Conclusion

This study indicates that herbal medicine may be used in place of conventional medicine to treat livestock diseases by indigenous communities of Rif. Most of the local people depend upon their popular health care system especially in the remote areas where the facility of veterinary hospital is not available. Natural medicine is considered adaptable and sustainable to the local people because of its ease of availability, administration to animals, and simple modes of preparation. Ethnoveterinary knowledge is under severe risk due to deforestation, urbanization, overgrazing, overexploitation, expanding agricultural demands, and acculturating trend of village inhabitants. The richness of indigenous information on herbal medicine is a sufficient justification to extend the documentation process to other areas of Morocco to collect valuable data on existing ethnoveterinary practices and integrate them into the formal veterinary R & D system. So, further research is required on the evaluation of the anti-inflammatory and analgesic activities of these identified medicinal plants. Moreover, efforts should be undertaken to conserve effective medicinal plant species to prevent their extinction.

Availability of supporting data

Supplementary material related to this article can be obtained from the corresponding author on request.

Consent for publication

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CRediT authorship contribution statement

Noureddine Chaachouay: Conceptualization, Methodology, Investigation, Software, Formal analysis, Writing – Original Draft. Abdelhamid Azeroual: Software, Writing. **Bouchaib Bencharki:** Validation, Visualization Allal Douira: Visualization, Writing – Review & Editing. **Lahcen Zidane:** Validation, Supervision, Methodology, Project administration.

Declaration of Competing Interest

We certify that there is no conflict of interest with any financial organization regarding the manuscript.

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Supplementary materials

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